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Intense Ion Beam transport in Magnetic Quadrupoles: Experiments on Electron and Gas Effects

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Heavy-ion induction linacs for inertial fusion energy and high-energy density physics have an economic incentive to minimize the clearance between the beam edge and the aperture wall. This increases the risk from electron clouds produced by emission of electrons and gas from walls. We have measured electron and gas emission from 1 MeV K+ incident on surfaces near grazing incidence on the High-Current Experiment (HCX) at LBNL. Electron emission coefficients reach values of 130, whereas gas desorption coefficients are near 104. Mitigation techniques are being studied: A bead-blasted rough surface reduces electron emission by a factor of 10 and gas desorption by a factor of 2. We also discuss the results of beam transport (of 0.03-0.18 A K+) through four pulsed room-temperature magnetic quadrupoles in the High Current Experiment (HCX) at LBNL. Diagnostics are installed on HCX, between and within quadrupole magnets, to measure the beam halo loss, net charge and expelled ions, from which we infer gas density, electron trapping, and the effects of mitigation techniques. A coordinated theory and computational effort has made significant progress towards a self-consistent model of positive-ion beam and electron dynamics. We are beginning to compare experimental and theoretical results.

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